Analogue electronic circuits and systems

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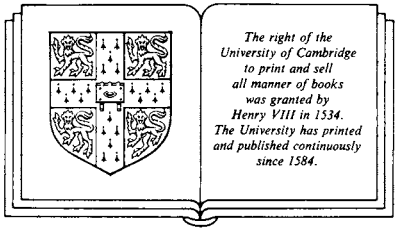

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Introduction

In recent years there has been rapid progress in electronic circuit design and the main reason for this is the advance in digital techniques. This volume differs from the texts which are available on the market nowadays in two respects. Firstly it covers only analogue electronic circuits and systems; secondly basic electronics is omitted so that appropriate emphasis can be given to the design of the most popular and useful analogue electronic circuits. The following are prerequisites for studying this text:

(a) P-N junction diodes: principles of operation both in the forward and reverse mode, characteristic equation, resistance and junction capacitance, Zener diodes.

(b) Junction transistors: principle of operation, common-emitter (CE), common-collector (CC) and common-base (CB) configurations, static characteristics, definition of active, cut-off and saturation regions, the concept of load lines and the need for biasing, the transistor as an amplifier.

(c) Amplifiers: voltage and current gains (A_v and A_i), input and output resistance (R_{in} and R_{out}), frequency response concept, the use of the h-parameter model of the transistor for circuit analysis, midband frequencies of the CE, CC and CB configurations and calculation of A_v, A_i, R_{in} and R_{out} for each case.

(d) Field effect transistor: principle of operation, static characteristics, load lines, biasing circuits, use as an amplifier.

(e) Positive and negative feedback and their advantages and disadvantages.

(f) Operational amplifiers: ideal amplifier, analysis of inverting, noninverting, differential, buffer and summer amplifiers, use of operational amplifiers as integrators and differentiators.

A list of books which comprehensively cover the above topics is given at the end of this volume. Standard symbols are used throughout the text and a glossary is included as one of the appendices.

In the second chapter the operation of several basic circuits which are commonly used in most integrated circuit chips is described. A section is also devoted to the analysis of multistage amplifiers and the ways of choosing the right configuration of transistor amplifiers for a particular stage. These are included in the text in order to acquaint the reader with the operational amplifier integrated circuit which is the building block of most analogue circuits. The principle of operation of tuned amplifiers is briefly explained in the penultimate section. In the last section, different types of power amplifiers are studied. Various types of heat sinks and their use in power circuits are also discussed in this section.

Chapter 3 deals with operational amplifiers in great detail, but at a level higher than the introductory one which is [one of the] required knowledge, as mentioned earlier. The circuits are analysed and designed assuming operational amplifiers to be ideal, but in practice they are not so. In this book, therefore, the chapter starts with the imperfections in operational amplifiers, their effects on various operational amplifier circuits and the ways in which readers can minimise these effects. Several widely used linear and nonlinear circuits using operational amplifiers are discussed in the remaining sections of this chapter. One of the major applications of operational amplifiers is in active filters and therefore readers will find both resistor–capacitor and switched-capacitor type active filters, which are discussed in this chapter with design examples, rather useful. Principles of design of waveform and function generators and also analogue computation using operational amplifiers are comprehensively studied in the next section.

The next three chapters describe oscillators, phase-locked loops and different types of modulation respectively. Principles of design and operation of oscillators using transistors, operational amplifiers and quartz crystals have been presented. The most common uses of phase-locked loops in the field of communications and also in the field of control of motor speed are discussed to a limited extent, with a full treatment of the theory of phase-locked loops which will help readers to understand and design similar circuits.

In Chapter 7, under the heading of data acquisition and distribution systems, analogue-to-digital and digital-to-analogue conversion techniques are discussed in great detail. Sample-and-hold circuits, multiplexers and demultiplexers are also studied in great depth. Analysis of errors in individual circuits and also in complete systems are discussed. In the age of computerised measurement in research and in most aspects of control systems this chapter is a significant part of the text.

The last chapter deals with computer aided analysis and design of

electronic circuits. It describes various computer aided design models giving special attention to the Ebers–Moll model of a transistor. Models for bipolar junction and field effect transistors and also integrated circuits are described. Techniques of a.c. small signal, d.c. and transient analysis of circuits are discussed with the help of examples. Several commercially available computer programs are also discussed. Two widely used software packages are described with the aid of circuits and their analyses in order to make students familiar with the procedure for drawing and analysing various active and passive circuits.

To summarize it can be said that this volume on analogue electronic circuits and systems has been written mainly keeping in mind the requirements of undergraduate students at the intermediate level. Practising engineers interested in various aspects of analogue electronic circuit design will also find this text informative.